Impression of JAPAN

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シカゴ大学の Morrel H. Cohen 教授が，文部省外国人研究員（甲種）として，1979年1月1日～6月30日の間基研に滞在されました。Cohen 先生が到着されるまでは，「6カ月もの長い間大変だなあ！」というのが本音でしたが，またたく間にすぎてしまった6カ月でした。

当基礎物理学研究所は，昨年で創立25周年を迎え，“新しい”情況のもとで，「世界に開かれた高等研究所」を目指して“新しい”出発をしたばかりであることは，皆様も御存知のことと思います*。国際交流のセンターとして，出来るだけ多くの外国人研究者を招へいし，又，あらゆる機会をとらえて国際研究集会を開こうという趣旨ですから，そのことをCohen 先生にもお話して協力していただきました。

まず，なるべく多くの日本の研究者に会っていただくために，春の学会で特別講演をしていただいたのをはじめとして，京都以外の大学を訪問していただきました。特に地方を，と心がけて，広島，九州，金沢，新潟にお送りしました。中央の東京，大阪へも何度か出かけられました。

又，5月末には，丁度日本に滞在中の他の外国人研究者の方にも参加していただいて，基研短期研究会「ランダム系における金属・非金属転移」を開きました。この研究会も，上記の趣旨に沿って，公募形式の「開いた研究会」としました。全国から80人近くの研究者の方々が集まって下さり，非常な盛会になりました**。

「物性研究」からも，ガラス転移に関するCohen 先生の御仕事に関する原稿をお願いしてあったのですが，多くの人に会っていただくだけでも非常な大仕事で，ついに日本

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*）この詳細については，「基礎物理学研究所の将来」というパンフレットにまとめられていますので，御希望の方は，共同利用事務室まで請求して下さい。

**）この研究会の proceedings は，Progress of Theoretical Physics の supplement として，来春ごろに出版する予定です。

を出られるまでに原稿をいただくことは出来ませんでした。

最後に，日本の物理学者やその他諸々のことに関するCohenさんの印象記のようなものを書いていただこうかということになりました。これも忙しくて書けないままに終る心配がありましたので，対談風に話し合って，その中からエッセンスを抜き出したのが下の形にまとめられたものです。

基研の私の研究室から，中庭ごしに見えるCohen先生の2階の部屋を見上げて，電気がついていると，「あっ，もう来てるな」といつも思ったものです。忙しかったけどとても楽しい6カ月だったから，電気のつかない部屋はやはり淋しい気がします。

（1976. 7. 6　米沢記）

1. GENERAL IMPRESSIONS OF JAPAN AND THE JAPANESE PEOPLE.

YONEZAWA

First of all, I would like to ask you about your general impression of Japan. I understand that you visited Japan before, and it is more than 10 years since you last came to Japan. For the last 10 years, I think Japan has changed in many respects. The change is remarkable even to us who have been in Japan all the time. Therefore, it must look more marked to you who have come back to Japan after such a long absence.

COHEN

This is my third visit to Japan. My first visit was in 1961 for the Magnetism Conference, and my second was in 1968 for the Statistical Mechanics Conference. Both lasted three weeks. The present visit has been for six months. My impressions in '61 and '68 were of course more superficial than my present impressions. I have known Japanese people since 1950 and Japanese scientists since 1954.

My most overwhelming impression is of the great increase in prosperity since 1961. This shows up physically in the changed landscapes and cityscapes one sees as one travels through Japan. The changes are not always esthetic improvements, but there are distinct cultural and visual advantages to prosperity, notably in the improved conditions of the great natural monuments and treasures and of the museums. With prosperity there has been a relaxation, an ease that goes beyond mere material ease. There is the greater self confidence often found in countries with a rapid rise in standard of living, but there is more to it here — great success in industrialization and international trade has restored national pride. There is greater scope and movement in personal lives. There is more openness, though still far less than in other countries. The changes are of course more noticeable in the young. Though many aspects of traditional culture seem to be falling away, I have found greater knowledge of Japanese history and culture among educated Japanese than I had in my earlier visits.

Reading the newspapers and talking to Japanese from various walks of life produced in me the strong impression that the turning inward which occured in Japan after the war

has passed. The obsession with economic growth and prosperity is passing. Now Japan seems poised and ready to take on a position of international leadership in many areas consistent with its great economic power and cultural richness. Recognition that this should happen is not recent, but the uncertainty as to how and in what areas is now falling away.

2. PHYSICS AND PHYSICISTS IN JAPAN.

YONEZAWA

Secondly, I would like to know what you think about physics and physicists in Japan. The topics Japanese physicists choose, the style they take, the emphasis they put in their arguments, and, among other things, the philosophy they are based upon all these must be noticeably different from those of American and European physicists you are accustomed to. Especially, I should like to know what you think are the most characteristic features of Japanese physicists or their ways of doing physics. And, if there are some negative aspects, and I'm definitely sure there are some, then could you make some comments or give advice, concerning how we could overcome them?

COHEN

When I first got to know Japanese solid state and related physics around 1950 through reading the literature, it showed certain marked national characteristics. There was little experimental work, and much of what there was was not impressive. With the notable exception of the work on magnetism, much of the theoretical work tended to be very abstract. There was a tendency to be more interested in the beauty of a calculation than in its relevance or in the accuracy of the approximations made in relation to the physical situation under consideration. Certain sets of problems were fashionable here, while large areas were ignored. Presentations in print or verbally could leave one wondering what the point of the work was. Over the years there have been steady changes, and the cumulative effect has become quite dramatic. There is a thriving and very impressive experimental community. Certain facilities here are unique in the world. The standards for experimental physics are the international standards. Individual scientists are well supported, positive, confident,

etc. Interactions between theorists and experimentalists are strong, frequent, and often formalized in to collaborations. Experimentalists and theorists are clearly learning to talk to each other very well. The taste for abstract theory is still strong, and abstract theory is better now, more rigorous in execution and with more attention to connections with reality, when relevant. What is most dramatic, however, is the change in style, both in working and in communication, of the now much larger fraction of theorists interested in concrete problems and real materials. It is much more typically the international stype and is frequently simple, effective, and quite beautiful. I am still impressed with the common facility in formal analysis, and I sometimes amuse myself by speculating that it arises from a superiority in abstract and symbolic thinking induced by mastering "Kanji".

Esthetic considerations still seem to be of great importance. National characteristics remain: brevity, formal facility, concern with elegance, a tendency to work in areas about the importance of which there is a consensus, etc. However, the progress towards internationalization of the subjects of research in physics, the methods, and the style has been very great, whatever the pain it has caused.

With regard to continuing the process of internationalization of physics, continued emphasis on the international literature, on international conferences, on foreign travel, on foreign visitors to Japan, and on cooperation in setting up international research centers is all that can be done.

3. RELATING TO MY WORK SINCE COMING HERE.

YONEZAWA

Now, changing our subject a little bit, could you tell us what are your current interests, in particular relating to your work since you have come here this time?

Amorphous semiconductors, which you are interested in and which I also am interested in, have recently attracted increasing attention in connection with energy problems. Including energy problems, sceince at the present time seems to give a great influence to the mankind just as it used to be at various periods in the past. From this respect, what do you think we should do or should not do as scientists to contribute towards the solution of energy

problems and other problems of great importance for ourselves and for future generations?

COHEN

While here I have emphasized research in two areas, amorphous semiconductors and the nature of glass. My work on glass has been entirely fundamental in character. My work on amorphous semiconductors has been both basic and applied. The basic work has concerned itself with the electronic structures of ideal amorphous semiconductors, materials with no structural defects. The applied work has related to solar energy.

Amorphous semiconductors can be used as selective absorbers in the generation of solar thermal energy. They can be used for photovoltaic cells for the generation of electricity from sunlight. They can be used as electodes in cells for solar photochemistry or photoelectrochemistry. In all these applications the great advantage of amorphous semiconductors is that the thin film technologies by which the devices can be fabricated promise to be very cheap, cheap enough for economic feasibility of solar energy if certain efficiency goals can be met, e.g. $\gtrsim 10\%$ efficiency for photovoltaic cells. Progress in improving the efficiencies of photovoltaic cells has been very rapid, and the prognosis is good. Moreover, success with photovoltaics would accelerate developments in photochemistry, etc. It is my hope that large scale research efforts will be launched soon in Japan and in the US, oriented towards improving photovoltaic efficiencies.

To do so, a lot of basic materials research and experimental physics has to be done. What are the kinetic processes occurring in film formation which establish film structure? What limits mobility? What limits lifetimes? What is the best yield one can get? What is the theoretical limit to the efficiency? In examining these questions, one quickly realizes that the lower the density of localized states in the gap, the better in all respects, and that brings one to the electronic structure of ideal amorphous semiconductors, my current concern. What is the density of localized states in the gap of an ideal amorphous semiconductor? Understanding this basic question would lead us towards the goal of practical solar energy.

Another concern of mine relates to the most efficient extraction of oil from underground reservoirs. Clearly, the more efficiently one can extract the oil the longer we shall have to set in place alternative enrrgy sources. The oil is found in porous rocks. To design

an optimal drilling strategy one needs a permeability map of the reservoir, *inter alia.* To make a permeability map, one needs to know more about the physics of inhomogeneous materials than one knows now. The rocks are porous, but they don't appear to have a finite percolation threshold. Much theoretical and experimental work will have to be done to bring the theory of these porous rocks studied as inhomogeneous materials to the necessary level of development.

You have asked what we should do as scientists to contribute towards the solution of energy problems and other problems of great importance for future generations. Two things. First, we must all continue to build our treasure-house of basic knowledge upon which most technological and much social progress will depend in the future. Second, we can identify specific areas of basic research which can have a direct and even an immediate impact on such great social problems. Amorphous semiconductors and the physics of porous rocks of the oil bearing kind are two examples drawn form my own experience. Of course, one can always abandon basic research and more into applied research or technology and so serve society in the short term. However, if too many are encouraged to do that, we shall face disaster in the long run as our well of basic knowledge runs dry.

4. THE NEW POLICY OF THE RIFP.

YONEZAWA

Finally, I would like to know your opinion of our new policy of Research Institute for Fundamental Physics (RIFP). Let me first explain what is our new policy and what are our motivations for taking this policy. This institute was founded 26 years ago in memory of the fact that Prof. Yukawa got the Nobel Prize as the first Japanese. It was not long after the end of World War II. There were not many places where people could do physics. Therefore, this institute served as a center of physicists all over Japan and a number of small conferences were held here. The institute was a center not only from an economic point of view but also from mental or psychological point of view. Physicists came here to meet friends, to talk physics and to get encouraged. After 26 years, the situation has been changed enormously. Physicists have much more money, though still not enough.

M. H. COHEN

There are more staff posts, more books and more facilities at various universities. In addition to that, physics has become more and more international and we cannot confine ourselves within one country alone.

Reflecting these circumstancial changes, we have to change the role of our institute. Since we had the 25th anniversary last year, we had discussions over and over again to find out what should be our new policy. We came to the conclusion that our institute intends to be an advanced research intitute open to the world. We want the institute to be the center for the international exchange of physicists. We wait to invite as many foreign physicists as possible, and we plan to hold international conferences and schools at least once a year, some under the name of Kyoto Summer Institute (KSI) and others somewhat more informally.

Because I have told you many times about this new policy of ours since you have come to Japan, I'm sure you now understand it very well. I want to know what you think about it. Actually, you are one of the first test cases of our new policy as I told you.

COHEN

I think the policy is an excellent one. It seems to have worked in my case in that I have had useful interactions with many scientists over a very wide range of topics in informal discussions, seminars, and conference talks. Such interactions, when successful, will clearly move you towards the goals you have set. The policy seems well conceived, easy to effect, and a natural next step in the present circumstances.

You have presented the policy as though it were to benefit only Japanese scientists and science. In my case, I learned a great dial from many physicists. What I learned will have a major impact on my own research in the future. I feel that my own outlook has become more international. Please do not be too modest about the benefits your new policy confers on those foreigners fortunate enough to be invited as visitors or as conferees.

My impression is that the new policy will stimulate additional activity in the Institute without eliminating much of the present activities. Therefore, for the new activities to proceed on a meaningful scale some additional funding is necessary. The case you have put to me for the new policy is a forceful and convincing one. It should be used to elicit the needed funds.

Such activities as envisioned in your new policy all take place within Japan. One should go beyond that and think about Japan's participation in international research centers as a natural next step. Both are needed.

(1979. 6. 30)